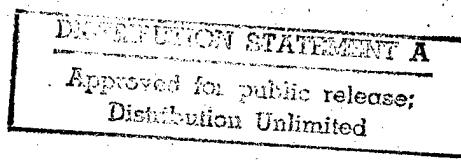


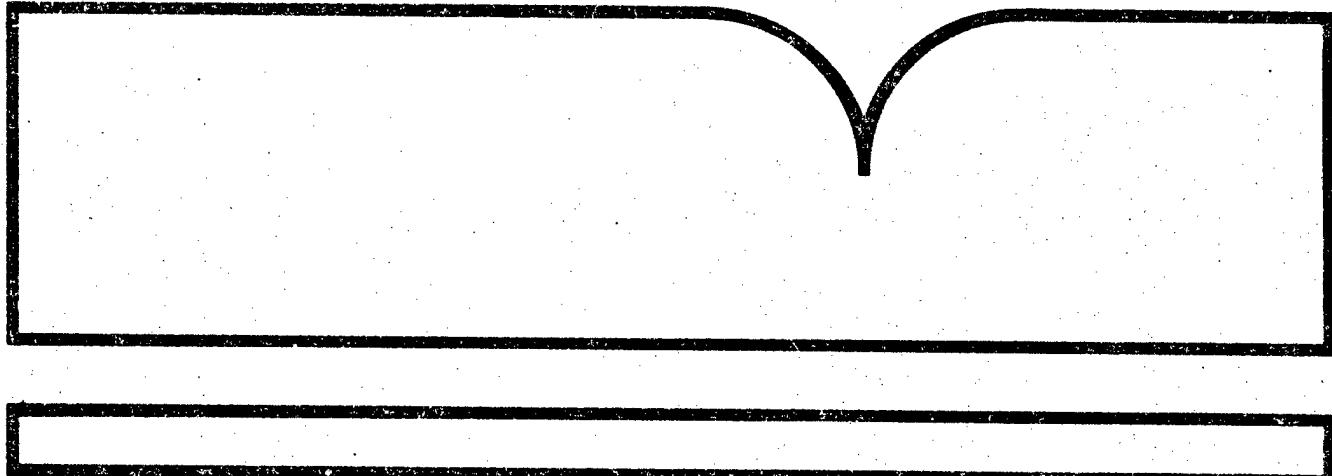
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Program: Evaluation of DOE's  
(Department of Energy's) Answers to  
Questions on X-Ray Laser Experiment

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GAO

Briefing Report to the Chairman,  
Subcommittee on Procurement and  
Military Nuclear Affairs  
Committee on Armed Services  
House of Representatives

June 1986

## SDI PROGRAM

# Evaluation of DOE's Answers to Questions on X-Ray Laser Experiment



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The briefing report responds to a request that GAO review the Department of Energy's (DOE's) answers to a series of questions raised about the x-ray laser program which DOE is conducting for the Department of Defense's (DOD's) Strategic Defense Initiative Organization (SDIO). Many of these questions resulted from press reports, especially a November 12, 1985, Los Angeles Times article. Essentially, GAO found the x-ray laser program is a research program with many unresolved issues. In their opinion, there was no 'design flaw' in the diagnostic instrumentation as mentioned in the Los Angeles Times article. However, analysis of test data by Lawrence Livermore National Laboratory (LLNL) scientists raised questions about the accuracy of some experimental data. As a result, some diagnostic equipment was reconfigured. These unexpected measurement uncertainties are now much better understood. In the GAO's opinion, there was no need to delay the latest x-ray laser nuclear test.

KEYWORDS: \*X-ray lasers, \*Strategic defense initiative.

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UNITED STATES GENERAL ACCOUNTING OFFICE  
WASHINGTON, D.C. 20548

NATIONAL SECURITY AND  
INTERNATIONAL AFFAIRS DIVISION

B-223094

June 2, 1986

The Honorable Samuel S. Stratton  
Chairman, Subcommittee on Procurement  
and Military Nuclear Affairs  
Committee on Armed Services  
House of Representatives

Dear Mr. Chairman:

This briefing report responds to your May 14, 1986, request that we review the Department of Energy's (DOE's) answers to a series of questions raised by Representatives Edward Markey and Bill Green about the x-ray laser program which DOE is conducting for the Department of Defense's (DOD's) Strategic Defense Initiative Organization (SDIO). Many of these questions resulted from press reports, especially a November 12, 1985, Los Angeles Times article. During the period from December 1985 to April 1986, we reviewed selected aspects of the program to answer these same questions at the request of Representatives Edward Markey and Bill Green.

We provided a detailed classified briefing on the results of our review to Representatives Edward Markey and Bill Green on April 10, 1986. We also provided you and Representative Marjorie Holt with the same briefing on May 14, 1986.

Essentially, we found the x-ray laser program is a research program with many unresolved issues. In our opinion, there was no "design flaw" in the diagnostic instrumentation as mentioned in the Los Angeles Times article. However, analysis of test data by Lawrence Livermore National Laboratory (LLNL) scientists raised questions about the accuracy of some experimental data. As a result, some diagnostic equipment was reconfigured. These unexpected measurement uncertainties are now much better understood. In our opinion, there was no need to delay the latest x-ray laser nuclear test. We also found that the x-ray laser program was not being arbitrarily accelerated. No tests in the atmosphere or space of the nuclear explosive driven x-ray laser are envisioned, according to LLNL officials.

B-223094

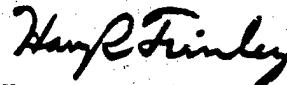
Our evaluation of DOE's answers to the questions is included in the appendix. The answers that DOE provided to your Subcommittee are generally consistent with what we found during our review of selected aspects of the x-ray laser program. Classification restrictions limit the amount of detailed information we can present in this unclassified briefing report.

We performed our work at DOD's SDIO and at DOE's Office of Military Applications, LLNL, Los Alamos National Laboratory (LANL), and Sandia National Laboratories (SNL). Also, we contacted members of the JASON group, which advises DOD and DOE on national defense scientific and technical issues. Our evaluation was based on a review of various x-ray laser program documents, reports, letters and memorandums, as well as interviews with program managers, scientists, and reviewers. Most of our work was performed at LLNL.

As requested by your office, we did not obtain official comments on this briefing report from DOD or DOE. As arranged with your office, copies of this briefing report are being furnished to Representatives Edward Markey, Bill Green, and Marjorie Holt. Also, we will send copies to the Secretary of Defense and the Secretary of Energy. Copies will be available to others upon request.

If there are any questions regarding the contents of this briefing report, call me on 275-4265.

Sincerely yours,



Harry R. Finley  
Senior Associate Director

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**ANSWERS TO QUESTIONS POSED BY  
CONGRESSMEN EDWARD MARKEY AND BILL GREEN**

1. How is the performance of the x-ray laser measured, and what is the nature of the design flaw that has been identified in the device mentioned in the press account? What effect does the flaw have on the data that has been gathered on the x-ray laser program? Do the problems that have been identified relate only to last spring's test or all of the x-ray laser tests that have been conducted to date?

**DOE's response**

There are four properties of the x-ray laser that determine its performance: (a) the total power in the laser beam; (b) the color of the laser light; (c) the size or spreading (divergence) of the laser beam; and (d) when the laser beam turns on and how long it lasts. The measurement of these properties is a difficult task because of the nuclear environment and the high intensity, short timescale of the lasing process. There was no "design flaw" in these experimental measurements. The high intensity laser pulse interacts strongly with the measuring device during the time of observation. A scientific question was how accurately we could make the measurements and, thus, whether the quoted absolute power was correct.

**GAO's evaluation**

The DOE response is consistent with the information we obtained during our review. We agree there was no "design flaw" as such, but cannot explain the basis for our conclusion in this unclassified document.

2. In addition to the measuring device that has had these problems, examine what other instruments are used to gather data on x-ray laser experiments and explain what kind of information they provide.

**DOE's response**

The color of the laser light is determined by a variety of high-resolution spectrometers. These spectrometers measure the line energy and intensity of the lasing transitions and also measure detailed atomic physics of laser materials. The size of the laser beam is determined by a one-dimensional imaging instrument. The time history of the laser beam is determined by the same diagnostic that measures the total power. This instrument measures the temporal shape of the laser beam, when the laser beam turns on relative to the nuclear pumping source and how long the laser beam lasts.

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GAO's evaluation

The DOE response is consistent with the information we obtained during our review.

3. The press reports indicate that tests show the x-ray experiment is lasing, but that tests do not provide sufficient information regarding the intensities such devices can achieve. Is this so? Please provide information on the kind of intensities determined to be necessary for the various military applications currently under consideration for an x-ray laser weapon and compare them to other candidate laser systems.

DOE's response

There is no controversy over whether x-ray lasing has been observed. The purpose of the ongoing research program is, among other things, to determine what intensities an x-ray laser can achieve.

X-ray lasers have several potential military applications including counterdefense, booster kill, post-boost vehicle kill, reentry vehicle kill and discrimination of reentry vehicle decoys. The technology requirements for each mission are different.

GAO's evaluation

The DOE response is consistent with the information we obtained during our review. None of the individuals named in the Los Angeles Times article (see question 9) questioned that lasing has occurred. As shown in question 1, absolute power calculation inaccuracies occurred in past tests.

4. Reports suggest that while there have been some adjustments to the measuring device, further adjustments to the device (that would permit more accurate readings of the laser's intensity) could not have been completed until six months after what the press reports identify as the "Goldstone" test. Is this the case? Provide an assessment of the feasibility of temporarily delaying testing until these technical problems had been resolved.

DOE's response

See classified answers.

GAO's evaluation

Provided in classified briefing.

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5. Is it true that the schedule for x-ray laser experiments is going to be accelerated? What is the justification for this acceleration? Provide an assessment of the validity of this justification.

DOE's response

Since its inception the x-ray laser program has been operating on a resource-limited basis. Because of the impact a Soviet x-ray laser would have on United States Strategic Defense Initiative (SDI) architectures, the Fletcher Panel strongly recommended acceleration of the x-ray laser program. The only way we have of assessing the potential of Soviet nuclear directed energy work is to conduct such research ourselves. If information on weapon feasibility for the counterdefense mission is to be provided to the Strategic Defense Initiative Organization (SDIO) in a timely fashion, the program must be accelerated.

GAO's evaluation

The DOE response is consistent with the information we obtained during our review. The Fletcher Panel recommended a technology-limited, not a resource-limited, program. The DOD and DOE officials we contacted stated acceleration is needed to provide data to SDIO in a timely manner.

6. What is the overall funding for the x-ray laser in FY 1986? Please provide a detailed breakdown of the types of activities supported by these funds. Is there a strong scientific and technical basis for accelerating x-ray laser funding at this time?

DOE's response

The overall funding of the x-ray laser program and a breakdown of the activities and the amount of funds supported by the program is classified. The basis for accelerating nuclear directed energy weapons (NDEW) research is to assess adversary threat at the earliest possible date.

GAO's evaluation

The DOE response is consistent with the information we obtained during our review.

7. We have heard that the SDI Program Office has a program that will provide \$38 million in contracts to the DOE weapons laboratories. Press reports indicate that these funds are being provided on "a reimbursement basis" for nuclear-related research. Is this so? What exactly will

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this money be used for? Will it support the x-ray laser program?

DOE's response

\$38 million in reimbursable funds are being made available from the SDIO. Of this \$38 million, the LLNL share is \$20 million. These reimbursable funds in the LLNL program will be used in areas of significant and legitimate Department of Defense (DOD) interests. Areas addressed by these funds are: systems analysis studies, weapon platform studies, and acquisition, pointing and tracking systems. These augmented funds potentially help to accelerate a more broadly based x-ray laser program.

GAO's evaluation

The DOE response is consistent with the information we obtained during our review. In fiscal year 1986, \$38.0 million is being provided by the Military Interdepartmental Purchase Request process to be used for matters of interest to the DOD. Of this, \$20.0 million is going to LLNL for the x-ray laser program. Only a small portion of the remaining \$18.0 million, going to LANL and SNL, is earmarked for the x-ray laser program. Detailed explanation of fund usage can not be provided in this unclassified document.

8. We have also heard reports that there may be an additional \$62 million available in DOD accounts, either in the SDIO budget or elsewhere, to support additional x-ray laser tests in FY 1986. Is this true? Just what will this money be used for? Are these additional funds fully justified?

DOE's response

The program is in a state where additional funds can be used to accelerate the rate of technical progress. If the additional \$62 million dollars in funds available from the DOD can be transferred to the DOE this money could be used to accelerate the rate of testing.

GAO's evaluation

The DOE response is consistent with the information we obtained during our review. DOD has proposed a one time \$62.0 million appropriation transfer to be divided between LLNL, LANL, and SNL. The majority of these funds, if approved, will go to LLNL to be used primarily for x-ray laser research. DOD and DOE officials we contacted told us these funds are needed to accelerate the x-ray laser program.

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9. The attached Los Angeles Times article indicates that several classified reviews of the x-ray laser program have called into question earlier claims for the weapon's success. The first of these critiques was issued as far back as August of 1984. According to the article, by last summer scientists from the Los Alamos laboratory, the Livermore laboratory and the Jason Group had all identified serious technical problems with this program. Please examine these internal reports and interview the individuals who prepared them. Provide an assessment of these critiques and their implication for further research on the x-ray laser program. Examine whether the officials responsible for managing the x-ray laser program took these criticisms fully into account in their planning for future research and testing of this device.

**DOE's response**

In all the classified reviews held to date there has been unanimous opinion that x-ray lasing has been demonstrated. In all the scientific and program reviews, the LLNL staff have used the most current and most accurate information available. Most of the scientific reviews have, in fact, been requested by LLNL in order to provide independent peer review of the results and progress. In all cases, we have accurately conveyed the current status of the x-ray laser program to all levels of government and the scientific community. No major disagreements with LLNL's presentation have been expressed. The outcome of the reviews have, in general, been enthusiastic support for the program as laid out by LLNL.

The program management has always used the most current information to plan for the future research and testing of the x-ray laser. Since there is still much to learn about x-ray lasers, there have been changes in the underground tests and their associated experiments to address the physics and systems issues of an x-ray laser weapon. The ongoing internal and external review process has been a normal part of the program planning, and we have always tried to incorporate any suggestions we have received during the review process. We know of no example where a major scientific concern was not fully considered prior to the planning or execution of an underground test or major experiment.

**GAO's evaluation**

The limited scope of our review and DOE's use of all inclusive terms does not allow us to express an opinion on the DOE response. However, we have no knowledge about the program that would cause us to question the accuracy of

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DOE's response based on our review of the x-ray laser program.

We interviewed all the individuals named as reviewers or critics in the Los Angeles Times article. These individuals were not outside or independent critics, but were program participants or peer reviewers. As such, they were offering constructive criticism. We also interviewed other individuals we identified as program reviewers.

Overall, the above individuals generally support the current x-ray laser program, but they have identified problems or issues which must be addressed. These issues were, or are, being considered by x-ray laser program managers.

LLNL officials also kept SDIO officials apprised of current program status. Program results were presented at a June 1985 briefing. When some of these results had to be modified, due to the measurement inaccuracies (See question 1), another briefing was held in July 1985 at which time the revised data was presented.

10. What explosive yields have been determined to be necessary for nuclear testing in support of research on the various military applications of an x-ray laser? According to current planning, at what point (if any) would explosive testing in the atmosphere or in space be needed?

DOE's response

See classified answers.

GAO's evaluation

Provided in classified briefing.

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